Medical Journal of Bakırköy

Med J Bakırköy 2021;17:125-129
DOI: 10.4274/BMJ.galenos.2021.62634

Research

Radiological Evaluation of Age- and Gender-Related Changes in the Blumensaat Line

Blumensaat Çizgisinde Yaş ve Cinsiyetle İlişkili Değişikliklerin Radyolojik Olarak Değerlendirilmesi

Veysel Kaplanoğlu[1], Hatice Kaplanoğlu[2]

[1]University of Health Sciences Turkey, Keçiören Training and Research Hospital, Clinic of Radiology, Ankara, Turkey
[2]University of Health Sciences Turkey, Dışkapı Yıldırım Beyazıt Training and Research Hospital, Clinic of Radiology, Ankara, Turkey

ABSTRACT

Objective: The position of the patella relative to the femur is critical in the evaluation of patellofemoral joint diseases. Blumensaat defined a line to evaluate patellofemoral congruence, which is still used clinically. This study aimed to evaluate age- and gender-related changes in the blumensaat line (BL).

Methods: Images of 229 patients, who underwent standard lateral knee radiography at 30° flexion, were retrospectively evaluated. The relationship between BL and interior pole of the patella was examined, and the variability of the measurements according to gender and age groups was investigated using statistical methods.

Results: Two hundred and twenty-nine patients (128 men; 101 women) were included in the study. The mean age was 41.96±13.41 years (39.63±13 years for men and 44.90±12.2 years for women). BL passed through the lower pole of the patella in only two (0.9%) of the 229 patients. No statistically significant difference was found in the BL measurement of men and women (p>0.05). There was also no statistically significant relationship between age and these distance values (r=-0.112; p>0.05).

Conclusion: It was concluded that there was no difference between genders and different age groups in terms of BL measurements.

Keywords: Blumensaat line, patellar height, gender, age, radiography

ÖZ

Amaç: Patella-femoral eklem hastalıklarının değerlendirilmesinde, patellanın femura göre pozisyonu çok önemlidir. Blumensaat (BS) patella femoral uyumu değerlendirmek için BS hattını tanımladı. Bu metod klinik kullanımda hala değerli olan bir yöntemdir. Bu çalışmanın amacı BS çizgisinde, yaş ve cinsiyetle ilgili değişiklikleri değerlendirmektir.

Gereç ve Yöntem: 30° fleksiyonda standart lateral diz radyografisi çekilen 229 hastanın görüntüleri retrospektif olarak değerlendirildi. BS çizgisi ve patella alt kutbu arasındaki ilişki incelendi, ölçümlerin cinsiyet ve yaş gruplarına göre değişkenliği istatistiksel yöntemlerle araştırıldı.

Bulgular: İki yüz yirmi dokuz hasta (128 erkek ve 101 kadın) çalışmaya alındı. Hastaların yaş ortalaması 41,96±13,41 idi (kadınlarda ve erkeklerde sırasıyla 44,90±12,2, 39,63±13). BS hattı 229 hastanın sadece 2'sinde (% 0.9) patellanın alt kutbundan geçmekteydi. BS ölçümü ile kadın ve erkekler arasında istatistiksel olarak anlamlı fark bulunmadı (p>0,05). Hastaların yaş grupları ile bu mesafe değerleri arasında istatistiksel olarak anlamlı bir ilişki yoktu (r=-0,112, p>0,05).

Sonuç: Çalışmamızda, BS ölçümünde farklı cinsiyet ve yaş grupları arasında fark olmadığı sonucuna varıldı.

Anahtar Kelimeler: Blumensaat çizgisi, patella yüksekliği, cinsiyet, yaş, radyografi

Address for Correspondence: Hatice Kaplanoğlu, University of Health Sciences Turkey, Keçiören Training and Research Hospital, Clinic of Radiology, Ankara, Turkey
Phone: +90 505 892 30 61 E-mail: hatice.altnkaynak@yahoo.com.tr ORCID ID: orcid.org/0000-0003-1874-8167

Cite as: Kaplanoğlu V, Kaplanoğlu H. Radiological Evaluation of Age- and Gender-Related Changes in the Blumensaat Line. Med J Bakırköy 2021;17:125-129

Received: 28.08.2020
Accepted: 22.06.2021

INTRODUCTION

The position of the patella relative to the femur is important for the evaluation of patellofemoral joint diseases. Most of patellofemoral joint diseases are based on a mismatch between the patella and femoral components (1). In 1938, on a lateral knee X-ray, Blumensaat described a line, in which the inferior pole of the patella was aligned with a line drawn from the roof of the intercondylar notch to the anterior of the knee joint (2). The vertical height above this line should be measured with the inferior pole of the patella, and the normal distance is defined as zero. Values greater than 10 mm are classified as patella alta (2) (Figure 1).

Patellar height measurements based on the blumensaat line (BL) are not affected by the patellar bone length or the angle between the BL and femoral shaft (BL-FS). Therefore, the BL method is more practical and reliable than indirect methods (3,4). However, some researchers suggest that BL varies at different BL-FS and flexion angles, resulting in inaccurate measurements (5-8).

Although the BL method is reported to be inconsistent with other patellar height measurement methods, the correlation between other measurement methods is also weak (9). In the clinical use of direct methods, BL remains to be an important parameter despite the controversial findings. Therefore, recently, it has been used more as a suitable reference point in newly described methods (3,4).

A limited number of studies, showing the accuracy of the BL method and affected variables, exist in the literature. This study aimed to investigate changes in BL measurements according to gender and age.

METHODS

Patients

The study included 229 patients, aged 18 to 60 years, who presented to our hospital with an anterior knee pain between January 2019 and July 2020 and underwent standard lateral knee radiography at the radiology clinic. Patients who had a history of previous knee surgery and those with developmental knee joint pathology or posttraumatic knee joint deformity, effusion, soft tissue pathology, or severe degeneration were excluded from the study. The demographic data of the patients were recorded.

To standardize the radiological measurements, lateral knee X-rays taken at 30° flexion were examined. The flexion angle was obtained by measuring the angle between the FS and tibia (Figure 2). This ensures that the slack is in the patellar tendon and determines the relationship between

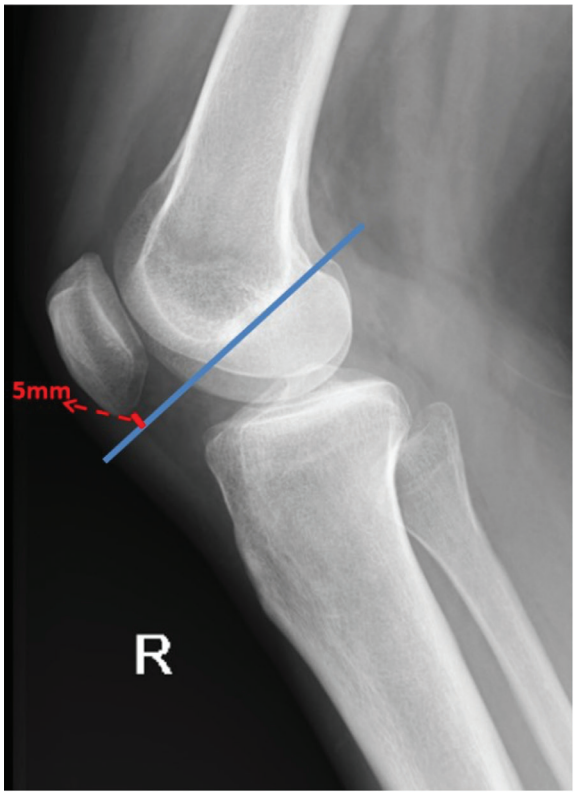

Figure 1. Blumensaat line

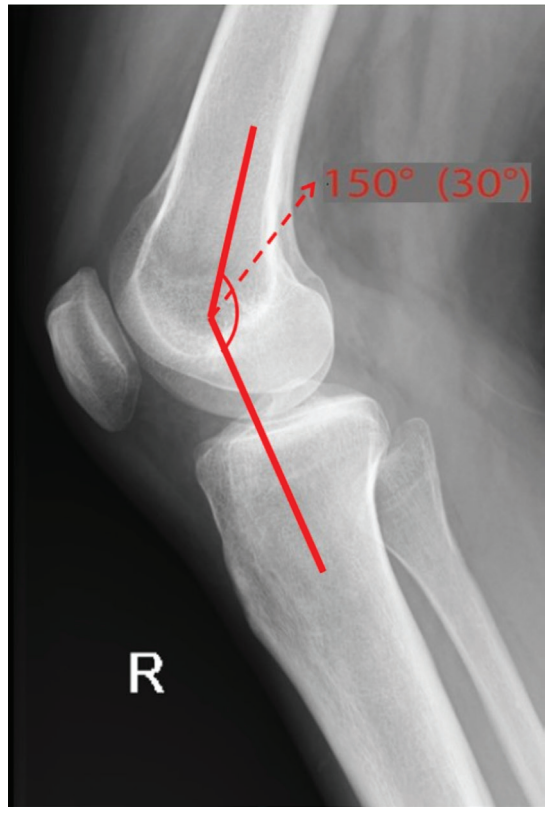

Figure 2. Knee joint flexion angle

BL and inferior pole of the patella (10). Measurements were undertaken directly on the X-rays by the same radiologist for each patient, using the digital picture archiving system (Figure 3). Before the study, approval was received from the clinical research ethics committee of our hospital, and the study was conducted in accordance with the principles of the Declaration of Helsinki. Informed consent was obtained from all individuals participating in the study.

Statistical Analysis

For the descriptive statistics related to the continuous data, mean, standard deviation, median, and minimum and maximum values were used, while discrete data were expressed as percentages. The Shapiro-Wilk test was used to analyze the conformance of the data to a normal distribution. The Mann-Whitney U test was conducted to compare age and knee BL-patella values according to gender. The chi-square test was used in the group comparisons (cross-tables) of nominal variables. The relationship between age and knee BL-patella values was examined using Spearman's correlation coefficient. IBM SPSS Statistics v. 20 was used for statistical evaluations, and $p<0.05$ was considered the statistical significance limit.

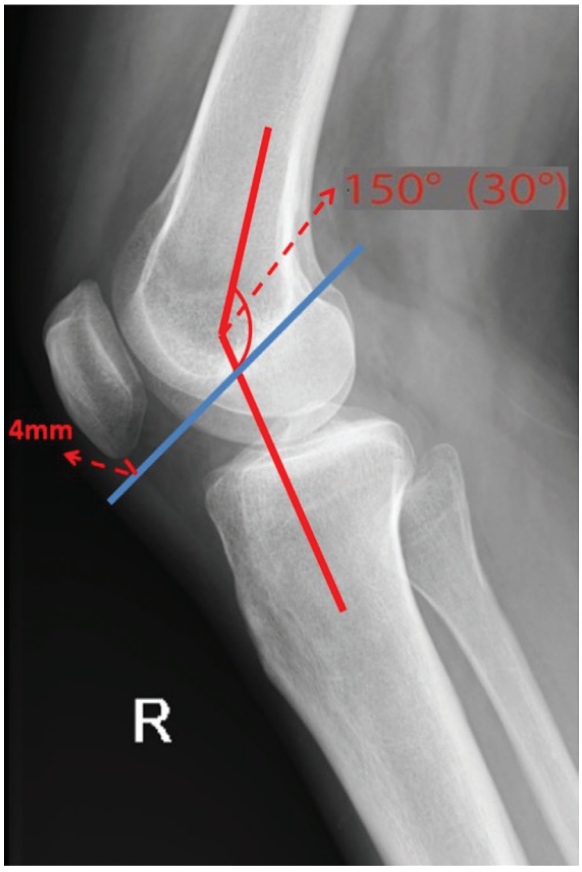

Figure 3. Digital measurement on the direct X-rays using the digital image archiving system

RESULTS

The ages of the 229 patients included in the study ranged from 18 to 60 years, and the mean age was 41.96±13.41 years. Of the patients, 44.1% were women, with a mean age of 44.90±12.2 years, and 55.9% were men, with a mean age of 39.63±13.89 years. Meniscal tears existed in 40.6% of the patients, degenerative changes, 47.2%, meniscal degeneration, 51.5%, and degeneration in the anterior cruciate ligament, 7.4% (Table 1).

When determining the height of the patella using the BL method, the position of the inferior pole of the patella (high or low) and its distance in millimeters are measured according to BL. In this study, the mean distance between the BL and inferior pole of the patella was 7.62±4.92 mm (7.06±4.59 mm in women; 8.06±5.14 mm in men). There was no significant difference in terms of the BL measurement values between men and women ($p>0.05$) (Table 2).

In only two (0.9%) of the 229 patients, BL passed straight through the inferior pole of the patella. Patella alta was identified in 49 patients (21.4%) (Figure 4). This condition was seen in 21 (20.8%) female patients and 28 (21.9%) male patients (Table 3). Patella baja was not detected in any patient. There was no significant relationship between the age groups of the patients and these distance values ($r=-0.112$; $p>0.05$) (Table 4).

Table 1. Distribution of gender, meniscal tear, degenerative changes, and anterior cruciate ligament among the patients

	n	%
Gender		
Female	101	44.1
Male	128	55.9
Meniscal tear		
Absent (0)	136	59.4
Present (1)	93	40.6
Degenerative changes		
Absent (0)	121	52.8
Present (1)	108	47.2
Meniscal degeneration		
Absent (0)	111	48.5
Present (1)	118	51.5
Degeneration in ACL		
Absent (0)	212	92.6
Present (1)	17	7.4

ACL: Anterior cruciate ligament

Table 2. Comparison of the age and blumensaat line measurements between women and men

	Women		Men		
	Mean ± SD	Median (min-max)	Mean ± SD	Median (min-max)	p
Age, years	44.90±12.21	48 (18-60)	39.63±13.89	42 (18-60)	0.005
Blumensaat line measurement	7.06±4.59	6.5 (0-22)	8.06±5.14	7.75 (0-26)	0.152

SD: Standard deviation, Min-max: Minimum-maximum

Table 3. Distribution of the patients according to the patellar height

	n	%
Knee BL-patella		
=0	2	0.9
≤10 mm	180	78.6
>10 mm	49	21.4

BL: Blumensaat line

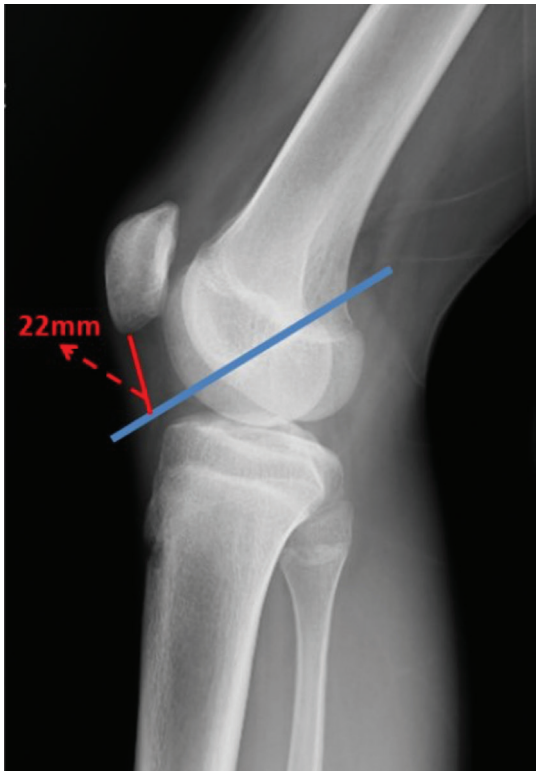

Figure 4. Measurement of the Blumensaat line in patients with patella alta

Table 4. Correlation between the patients' age and BL measurements

	Age	
	r	p
Knee BL-patella	-0.112	0.090

BL: Blumensaat line

DISCUSSION

Patellofemoral congruence is important for the etiology of anterior knee pain. The use of BL is accepted as a pioneering method in measuring the patellar height (2). According to Jacobsen et al., (10) since BL was first defined, this measurement has not been standardized, and thus, it provides varying results, depending especially on the knee flexion angle. However, Seyahi et al., (4) who compared the accuracy of BL methods in different BL-FS angles, determined that the accuracy of the BL method and size of the patellar bone were not affected by different BL-FS angles, but they also noted that the intercondylar notch depth might impact BL measurements. In this study, we examined whether the depth of the intercondylar notch may vary according to age and gender (11).

For patellar height measurements, many direct methods using patellar and femoral reference points were described, which mostly used BL as the reference point (3,12,13). Therefore, BL remains important in clinical use (11). In Andersen et al., (14) study, where they measured the patellar height based on BL in 256 knees, 207 patients were diagnosed with patella alta. Based on the study, it was revealed that the intercondylar notch roof-femoral diaphyseal angle affected the position of BL relative to the patella, which could provide different values varying from one person to another.

In another study, patella alta or baja was detected on lateral radiograph images, at 30° flexion, in 7.5% of patients. When the correlation of these values with other indirect methods was evaluated, the results were found to be consistent (1). According to the literature, the BL method shows the most significant correlation with the Insall-Salvati method (4,15,16). In a similar study conducted on Turkish patients, patella alta was detected on lateral radiograph images, at 30° flexion, in 9.47% of the patients (11). In the current study, patella alta was detected in 21.4% of the patients, while patella baja was not observed. Compared with the other study in Turkey, due to the higher number of patients in the sample, patella alta was detected in more patients.

Studies existing in the literature show that patellar height measurements may be affected by personal characteristics, such as ethnicity, age, and gender. Karadimas et al. (17) and Leung et al. (18) stated that ethnicity played an important role in patellar height. They reported that patellar height was higher, especially in Arabian, African, and Chinese populations, compared with the European population.

Norman et al. (5) and Egund et al. (19) emphasized that patellar height was affected by gender differences in direct measurements. Farrow et al. (20) stated that the intercondylar notch structure was narrower and shallower in women. The reference point of BL is the roof of the intercondylar notch; therefore, it was considered that the difference in the notch depth between genders might have affected the results (11). Değirmenci et al. (11) found a significant difference in terms of patellar height between genders. They reported that women had a higher patella than men, but the height of the patella did not significantly differ between the age groups (11). Moreover, studies in the literature show that patellar height is not affected by gender differences when measured using the BL method (16,21,22). Thus, there is still no consensus on the effect of gender differences in BL measurements. In this study, no difference was found between genders or different age groups in terms of the patellar height measurements using the BL method.

CONCLUSION

There was no difference between genders and different age groups in terms of BL measurements.

ETHICS

Ethics Committee Approval: The study were approved by the Health Sciences University Dışkapı Yıldırım Beyazit Training and Research Hospital of Local Ethics Committee (Protocol number: 10.08.2020/93/10).

Informed Consent: Consent form was filled out by all participants.

Authorship Contributions

Surgical and Medical Practices: V.K., Concept: H.K., Design: H.K., Data Collection or Processing: H.K., Analysis or Interpretation: H.K., Literature Search: H.K., Writing: V.K.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

REFERENCES

1. Seil R, Müller B, Georg T, Kohn D, Rupp S. Reliability and interobserver variability in radiological patellar height ratios. Knee Surg Sports Traumatol Arthrosc 2000;8:231-6.
2. Blumensaat C. Die Lageabweichungen und Verrenkungen der Kniescheibe. Ergebnisse der Chirurgie und Orthopädie. Springer: Heidelberg; 1938, 149-223.
3. Hanada M, Takahashi M, Koyama H, Matsuyama Y. Assessing the validity of the modified Blumensaat method for radiographic evaluation of patellar height. Eur J Orthop Surg Traumatol 2015;25:757-62.
4. Seyahi A, Atalar AC, Koyuncu LO, Cinar BM, Demirhan M. Blumensaat çizgisi ve patella yüksekliği [Blumensaat line and patellar height]. Acta Orthop Traumatol Turc 2006;40:240-7.
5. Norman O, Egund N, Ekelund L, Rünow A. The vertical position of the patella. Acta Orthop Scand 1983;54:908-13.
6. Brattström H. Patella alta in non-dislocating knee joints. Acta Orthop Scand 1970;41:578-88.
7. Carson WG Jr, James SL, Larson RL, Singer KM, Winternitz WW. Patellofemoral disorders: physical and radiographic evaluation. Part II: Radiographic examination. Clin Orthop Relat Res 1984;185:178-86.
8. Igbigbi PS, Msamati BC, Ng'Ambi TM. Intercondylar shelf angle in adult black Malawian subjects. Clin Anat 2001;14:254-7.
9. Ng JP, Cawley DT, Beecher SM, Lee MJ, Bergin D, Shannon FJ. Focal intratendinous radiolucency: A new radiographic method for diagnosing patellar tendon ruptures. Knee 2016;23:482-6.
10. Jacobsen K, Bertheussen K, Gjerloff CC. Characteristics of the line of Blumensaat. An experimental analysis. Acta Orthop Scand 1974;45:764-71.
11. Değirmenci E, Yücel İ, Özturan KE, Karaduman ZO, Karaca E. Evaluation of the age and gender related changes in the Blumensaat line. Surg Radiol Anat 2020;42:641-5.
12. Phillips CL, Silver DA, Schranz PJ, Mandalia V. The measurement of patellar height: a review of the methods of imaging. J Bone Joint Surg Br 2010;92:1045-53.
13. Biedert RM, Albrecht S. The patellotrochlear index: a new index for assessing patellar height. Knee Surg Sports Traumatol Arthrosc 2006;14:707-12.
14. Andersen PT. Congenital deformities of the knee joint in dislocation of the patella and achondroplasia. Acta Orthop Scand 1958;28:27-50.
15. Lu W, Yang J, Chen S, Zhu Y, Zhu C. Abnormal Patella Height Based on Insall-Salvati Ratio and its Correlation with Patellar Cartilage Lesions: An Extremity-Dedicated Low-Field Magnetic Resonance Imaging Analysis of 1703 Chinese Cases. Scand J Surg 2016;105:197-203.
16. Verhulst FV, van Sambeeck JDP, Olthuis GS, van der Ree J, Koëter S. Patellar height measurements: Insall-Salvati ratio is most reliable method. Knee Surg Sports Traumatol Arthrosc 2020;28:869-75.
17. Karadimas JE, Piscopakis N, Syrmalis L. Patella alta and chondromalacia. Int Orthop 1981;5:247-9.
18. Leung YF, Wai YL, Leung YC. Patella alta in southern China. A new method of measurement. Int Orthop 1996;20:305-10.
19. Egund N, Lundin A, Wallengren NO. The vertical position of the patella. A new radiographic method for routine use. Acta Radiol 1988;29:555-8.
20. Farrow LD, Chen MR, Cooperman DR, Victoroff BN, Goodfellow DB. Morphology of the femoral intercondylar notch. J Bone Joint Surg Am 2007;89:2150-5.
21. Berg EE, Mason SL, Lucas MJ. Patellar height ratios. A comparison of four measurement methods. Am J Sports Med 1996;24:218-21.
22. Udoaka AI, Bienonwu EO. Assessment of the patellar height ratios in normal adult Nigerians. Asian J Biomed Pharm Sci 2013;3:1-3.